Automated Baseline Change Detection (ABCD)

Developer: Lockheed Martin
Contract Number: DE-AR21-94MC31191
Crosscutting Area: Robotics & CMST

Mixed Waste
FOCUS AREA

Problem:

Regulations require weekly inspections of thousands of barrels of mixed waste stored at DOE sites. Manual inspection processes are time consuming, of inconsistent quality, and expose humans to toxic and radioactive materials. Other DOE projects are addressing the automated acquisition of optical images and partial image analysis with the Stored Waste Autonomous Mobile Inspector (SWAMI), the Intelligent Mobile Sensor System (IMSS), and A Robotic Inspection Experimental System (AIRES). But these image analyses do not detect all required potential failures.

Solution:

This project enhances both the reliability and validity of barrel inspection by detecting any change in the visual appearance of a barrel. This is done by comparing a current inspection image with an archived baseline image, hence the name Baseline Change Detection (BCD). Thus ABCD is not limited to only known changes. Any change, whether it is recognized as a potential hazard or not, is identified.

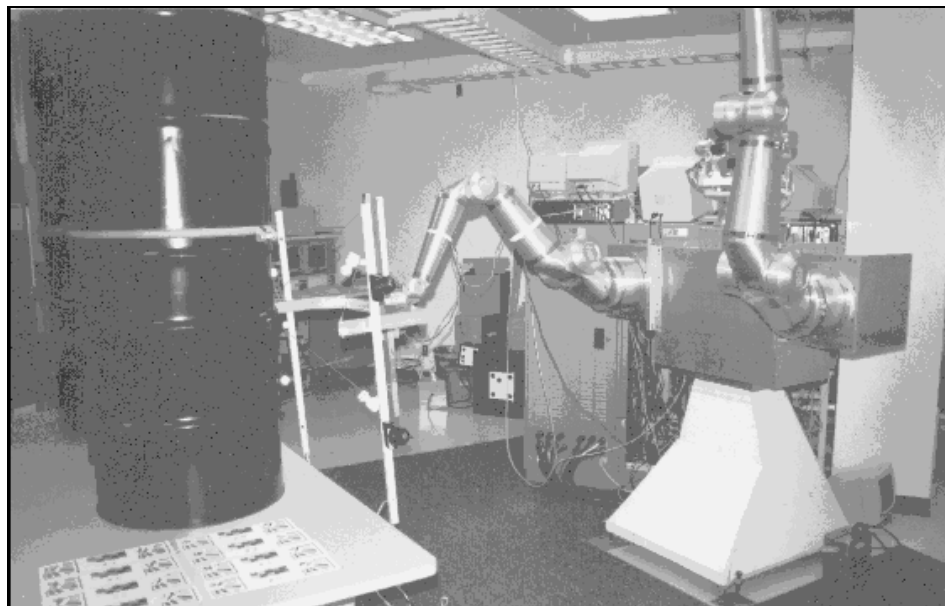If further interpretative analysis, such as rust detection, verifies that the change is benign, then no further action is required. If interpretative analysis is not familiar with the observed type of change, or if the change is not benign, then human operators are notified of the potentially hazardous change. Note that depending upon operational considerations, no operator action is mandatory for benign changes. Benign changes may still be used for trend analysis.

Benefits:

‣Automatic detection of any visual change on the barrel surfaces

‣Decreased risks and increased efficiency

‣Reliable early warning of storage problems with minimal image understanding or human inspection

Technology:

Lockheed Martin's ABCD sensor system integrates robot control, image processing, and the Kinetic Sciences, Inc. Eagle Eye system to produce a system that acquires and identifies the target, computes sensor pose, and rapidly and precisely repositions the sensor.

The ABCD project embodies two key technical strategies: (1) practical, real-time determination barrel identification with full 3-D pose (position and orientation) relative to the sensors and (2) application of image registration to change detection through sensor repositioning and image transformation to match the pose of an archived image.

The main components of the ABCD system are shown in the figure. In routine operation, the base platform moves the sensor to a stack of barrels and stops when the sensor is nearly centered on the identification and pose label. The sensor precision-positioning system repositions the camera into the same relative pose that was used for an archived reference image. A new image is compared to the baseline reference image. Because the camera is precisely repositioned the image comparison is based on image subtraction with minimal translation for registration.

Changes, if any, are compared to operational criteria. Change analysis may be performed, such as spectral analysis and image interpretation, and additional images may be saved for later inspection and record keeping. For example, image interpretation may be used to reduce potential false positive changes.

If image interpretation concludes that the change is benign, the unit passes inspection. But if not benign or if still uncertain, then other actions, such as human notification, can be taken. In this manner, there is very low risk of inspection failure and human involvement is focused on the most important cases.

ABCD will be one of three drum inspection technologies to participate in a "bake-off" among other similar and competing technologies. The other two systems are the Intelligent Mobile Sensor System (IMSS, also developed by Lockheed Martin) and the Intelligent Inspection and Survey Robot (ARIES, developed by the South Carolina Universities Research and Education Foundation).

Contacts:

The Automation & Robotics Laboratory of Lockheed Martin's Palo Alto Research Laboratories develops key advanced technologies for teleoperations, telerobotics, and supervised, autonomously controlled robotic systems. It is supported in ABCD by Kinetics Sciences, Inc., developers of the Eagle Eye Vision Software System. For information on this project, the contractor contact is:

Principal Investigator:
Peter A. Berardo
Lockheed Martin
R & D Division 3251 Hanover St
Palo Alto, CA 94304-1191
Phone: (415) 424-2137
Fax: (415) 424-2854
E-mail:
berardo@lmsc.lockheed.com

DOE's Morgantown Energy Technology Center supports the Environmental Management - Office of Science and Technology by contracting the research and development of new technologies for waste site characterization and cleanup. For information regarding this project, the DOE contact is:

DOE Project Manager:
Clifford P. Carpenter
Morgantown Energy Technology Center
3610 Collins Ferry Road
Morgantown, WV 26507-8880
Phone: (304) 285-4041
Fax: (304) 285-4403
E-mail: ccarpe@metc.doe.gov

1995					1996												1997									
A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S

IMSS Phase III Start

ARIES Phase III Start

ARIES Demo @SC University

IMSS/ABCD Demo@Fernald

ARIES Demo @Fernald

IMSS/ABCD/ARIES Contract End

IMSS Demo@ INEL

ARIES Demo @LANL

IMSS Gate 5

ARIES Gate 5